the Online NewsHour

March 24, 2008 -

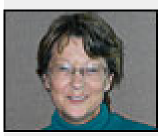
Experts Discuss Water Reuse

A new treatment plant in Orange County, Calif., is one of about 15 in the country to recycle wastewater back into the groundwater drinking water supply -- a plan called indirect potable reuse. Two experts answer your questions on water recycling.

Tom Hestwood of Marana, Ariz. asks

How is Orange County's system different from most water systems? Isn't wastewater supposed to be processed according to government standards then returned to the aquifer then ultimately drawn into the water supply and processed into potable water?

Cheryl McGovern responds:



Our water quality is regulated through two federal laws and many state laws. The Clean Water Act governs wastewater treatment and surface water quality. The Safe Drinking Water Act governs the protection and treatment of drinking water and ground water supplies. The CWA regulates discharges into waters of the U.S. through a permit program. The terms "pollutants" and "waters of the U.S." are defined further by water quality criteria to protect different beneficial uses of the water and generally waters of the U.S. are defined as surface waters.

Most water systems in the U.S. draw their water from a natural source -- surface water or a groundwater aquifer that is mainly recharged by sources other than treated wastewater effluent.

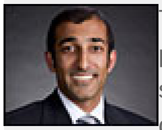
Orange County is treating wastewater to meet federal water standards under the Safe Drinking Water Act and Clean Water Act. Other water systems in this country don't treat wastewater to this high level of quality, as they discharge treated wastewater to surface water, such as a river or ocean, using a permit which includes pollution discharge limits based on CWA receiving water beneficial uses.

Beneficial uses and the quality of water necessary to protect them are established by individual states for different classes of water or water segments. Common beneficial uses include aquatic life, recreational and agricultural uses. The quality of water required to protect these uses (under CWA) is different than the quality of water required to meet drinking water standards (under SDWA).

However, the same water body that receives wastewater discharges may serve as a drinking water source further downstream, so all drinking water must meet SDWA regulations when it is comes out at the home faucet.

The Orange County Groundwater Replenishment Project uses reclaimed wastewater to recharge the drinking water aquifer with more advanced treatment of wastewater using water purification processes -- including microfiltration, reverse osmosis, ultraviolet light and hydrogen peroxide -- that treat the water to very high levels that meet state and federal drinking water standards before the highly treated water is returned to the groundwater basin, where it blends with other waters and is buffered with natural minerals before it enters the local drinking water supply.

Shivaji Deshmukh responds:



The Groundwater Replenishment System is a groundwater management and water supply project that supplements existing water supplies by providing a new, reliable, high-quality source of water to recharge the Orange County Groundwater Basin and protect it from degradation due to seawater intrusion. What makes this project unique is that the source water is treated sewage. Orange County Water District and Orange County Sanitation District constructed this project to, also, help defer the need for the construction of another ocean outfall which would discharge wastewater.

Many water providers within the United States draw their water from surface water (rivers, lakes, etc.) or groundwater, treat it, and deliver it to their residents. If these bodies of water have upstream agencies discharging highly treated wastewater into them, then they are generally considered "unplanned" indirect potable reuse. The GWR System is a planned indirect potable reuse project which means all the purified water is recharged into the environment prior to being ultimately pumped back out and delivered to the residents of North and Central Orange County.

The water produced out of the GWR System is not similar to other recycled water. The water meets and exceeds all federal and California state drinking water standards. After treatment, it is the highest quality water of all sources in Orange County. Many other recycled water projects are used for non-potable applications like watering lawns, golf courses or greenbelts.

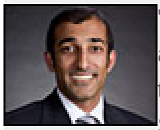
The GWR System facility purifies the highly treated sewer water by using a state-of-the-art, three-step process -- microfiltration, reverse osmosis and ultraviolet light with hydrogen peroxide. The water has already been treated twice by the Orange County Sanitation District.

OCWD experts have been testing the water purification technologies used in the GWR System for more than a decade. Constant water sampling and testing is part of the GWR System program to ensure water safety. Furthermore, the GWR System must be reviewed, approved and permitted by the California Department of Health Services and California Regional Water Quality Control Board to ensure public health, water quality and environmental compliance.

Richard Stevens of Manteca, Calif. asks

I work in wastewater treatment. I've been hearing the term "toilet-to-tap" for several years now. It's time to come up with a better term the consumer can 'swallow' to get away from the 'yuck' factor. Are any others being thrown around?

Shivaji Deshmukh responds:



"Toilet to Tap" is a misnomer implying the water is taken from the toilet and treated minimally and then delivered directly to customers. It fails to recognize the high level of treatment and time spent underground undergoing natural treatment. In the Groundwater Replenishment System, sewer water goes through stringent source control review, primary and secondary treatment at the Orange County Sanitation District; then microfiltration, reverse osmosis and ultraviolet light with hydrogen peroxide at Orange County Water District. The water is so pure and free of salt that minerals need to be added in to stabilize the water.

Indirect potable reuse is a more appropriate term. This means that water meets all drinking water or potable guidelines but will not be directly delivered to residents. In Orange County's case, the water will remain for at least 6 months to 2 years before being pumped back out.

Cheryl McGovern responds:

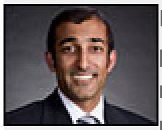
The term "toilet-to-tap" is catchy but inaccurate and, although we agree that a more accurate term for the consumer is needed, we don't have one at this time. The term evokes a negative emotional response to recycled wastewater that is unfounded because there is extensive treatment and removal of pollutants before the water comes out of the faucet for drinking.

However, Singapore's water reclamation facility utilizes microfiltration membranes, reverse osmosis membranes and ultraviolet disinfection to further treat wastewater effluent to produce a product water that they refer to as "NEWater."

Mickey Oskey asks

What happens to the "sludge" from the water treatment facility? I know that many places won't accept it as fertilizer.

Shivaji Deshmukh responds:



In Orange County, solids collected in the primary and secondary treatment processes are pumped to anaerobic digesters for solids stabilization. Digestion of the solids generates methane, which in turn produces power to operate the treatment facilities. Belt presses remove the water from the treated sewage sludge (biosolids).

Orange County Sanitation District strives to beneficially use the biosolids as well as to implement a sustainable program through diverse management options. Management options include using biosolids as a soil amendment on farms, as an ingredient to make compost for landscapes, gardens and erosion control products, creating fuel pellets as a source of green energy, as well as disposing of a small fraction of the biosolids at a landfill.

Cheryl McGovern responds:

Sludges from wastewater and water treatment facilities are typically put in a landfill or applied to farmland reclamation sites, although some sewage sludge is heat treated and reused as compost. A little more than 50 percent of the sewage sludge produced by the more than 16,000 municipal wastewater treatment plants in the U.S. is applied to land, mainly to farmland, as a soil conditioner and fertilizer.

We anticipate increased innovative uses of sludge over time. Ten years ago, the majority of sewage sludge in the states within EPA Region 9 (Arizona, California, Hawaii, and Nevada) was either treated to "Class B" pathogen reduction levels (some but not all pathogens removed) and used as fertilizer, or put in a landfill. Counties began passing ordinances restricting use of "Class B" sludge, and there was a trend towards treating to "Class A" levels (more extensive treatment), mostly by composting, but also by heat drying, long-term air-drying, or thermophilic digestion.

Currently, about 40 percent of the sludge in Region 9 is treated to Class A levels and 20 percent treated to Class B levels for land application, and most of the rest is put into landfills, with small amounts incinerated, used as fuel, or used as construction material. In the near future a number of outdoor compost operations will have to close because of more stringent air quality requirements, and there has been a trend towards more heat drying, with the product useable either as soil amendment or fuel. New indoor compost operations and negative static aerated pile compost operations have started up. Costs for use or disposal have gone up from about $20 per ton to $50+ per ton.

Throughout the country, municipalities are beginning to look to their sludge as a source of energy rather than a waste. The City of Los Angeles has started an experimental project in which sludge will be injected into a deep well (4,000+ feet); the designers are hoping that methane can be captured to make energy. The city of Sanford, Florida has a long-term contract to have the city's wastewater sludge converted to green energy. Also, sludge from two wastewater treatment facilities in King County, Washington are being used to grow canola on Yakima County farms that will be refined into biodiesel to power Metro Transit buses. An estimated 2 million gallons of homegrown biodiesel will be produced through this partnership.

A recent survey coordinated by the North East Biosolids and Residuals Association (NEBRA) discusses this further. The July 2007 final survey report and detailed appendices are available online at http://www.nebiosolids.org.

Scott Thomas of San Francisco, Calif., asks

Water conservation is one of two unavoidable issues we will face in the next 50 years. The other is energy conservation. On a per-gallon basis, what is the most energy-efficient method of water treatment today? What will it be 10 years from now?

Cheryl McGovern responds:

Energy needs vary depending upon a number of factors: (1) the quality of the source water and level of treatment required to produce the quality of water appropriate for the planned use of the treated water, and (2) the distance the water needs to travel from its source. In general, more treatment requires more energy.

Energy represents the largest controllable cost of providing water or wastewater services to the public. Most facilities were designed and built when energy costs were not a concern. Water treatment and wastewater treatment have different treatment and energy requirements. Expanding your question to wastewater treatment, the least energy-intensive wastewater treatment method would be facilitative lagoons (or wetland ponds) because they require no energy but they have large space demands, possible odors and may not meet applicable discharge standards. Water treatment systems using pristine source water may require little to no energy for treatment and disinfection. Both types of water systems would use little to no energy with gravity feed transmission pipes.

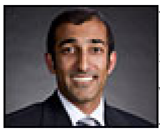
Reducing the amount of water entering the wastewater treatment facility also reduces the amount of energy required for treatment. Water conservation programs, such as EPA's WaterSense program, reduce the amount of water that needs to be treated. Grey water reuse for landscape irrigation and replacement of worn, cracked, or broken wastewater sewer pipes can prevent excess water infiltrating into the wastewater treatment facility and energy requirements. Recycling water at treatment facilities reduces water requirements onsite.

Wastewater treatment facilities also produce, or have the ability to produce, energy that can be used to offset the energy required for treatment. Anaerobic digesters and sludge can produce methane gas or biodiesel or electricity, and an increasing number of facilities are using renewable energy sources such as solar or wind or gas from nearby landfills to offset energy requirements. Several facilities are using excess capacity to process fats, oils and grease from restaurants to produce and sell biodiesel fuel.

The McKinsey Institute has studied different approaches for reducing energy consumption in general and has found energy efficiency to be the most cost-effective, promising approach. Wastewater treatment facilities may consume up to one-third the energy of a community, and energy utility companies such as Pacific Gas and Electric indicate these facilities can cut energy requirements by up to 25 percent with more energy efficient equipment and practices. Many power utility companies offer financial incentives to water treatment facilities to install new pumps, aeration systems, motors and disinfection systems.

For example, the Dublin San Ramon Services District had an energy audit and by following the audit recommendations they were able to treat 48 percent more wastewater while reducing the plant's annual energy use and cost savings to 2,232,000 kWh and $290,000 respectively. This savings allowed the District to earn $67,000 in incentives from PG&E. The new plant cost $2,209,000 more to build than a less efficient one, its annual energy savings and the incentives earned will result in the plant paying for itself in 6.6 years -- and then continue to save the District money and energy.

Shivaji Deshmukh responds:



The answer to this question depends on what level of treatment you perform and what the source water is. If you are treating water from a very pristine source like an alpine lake or a very protected groundwater basin, treatment energy usage could be minimal. If you are treating water with a lot of dissolved constituents in the water such as seawater, the usage could be comparatively high.

Ocean water contains approximately 40 times more salt than wastewater. Reverse osmosis is a high pressure process that separates dissolved constituents from the feed stream. The pressure requirements for reverse osmosis are dependent on the salt concentration of the feed water. Therefore, more energy is required for saltier feed streams.

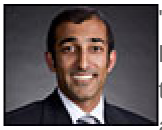
Conveyance of water uses significant amounts of energy in the state of California. Southern California gets water from Northern California and the Colorado River. Both sources are hundreds of miles away and water is pumped through large aqueducts using large amount of energy.

The Groundwater Replenishment System is an excellent example how a local supply of high quality water can be produced using 50 percent less energy than importing water from Northern California. Because of these environmental benefits, a number of environmental groups, including the Surfrider Foundation, Orange County Coastkeeper, Sierra Club, Association of Environmental Professionals and Earth Resource Foundation are in support of the project.

The GWR System has won several awards including the 2005 Governor's Environmental and Economic Leadership Award, which is the state of California's highest environmental honor, the 2004 Flex Your Power energy efficiency award, and the 2002 U.S. Environmental Protection Agency Environmental Achievement Award.

Irv Barnie asks
Why use "dirty" water when there's plenty of ocean water?

Shivaji Deshmukh responds:



"Dirty" is subjective. Wastewater in Orange County has approximately 1,000 milligrams per liter (mg/L) of salinity while ocean water has 40,000 mg/L. All coastal communities discharge treated wastewater into the ocean. With the treatment technologies present today, it is easier and more cost-effective to treat wastewater than ocean water.

Desalination of seawater costs more than indirect potable reuse projects. In the case of the Groundwater Replenishment System and most desalination plants currently in design, similar treatment schemes with pretreatment, reverse osmosis and disinfection are used. However, ocean water contains approximately 40 times more salt than wastewater. Reverse osmosis is a high-pressure process that separates dissolved constituents from the feed stream. The pressure requirements for reverse osmosis are dependent on the salt concentration of the feed water. Therefore, more energy is required for saltier feed streams. Estimates for indirect potable reuse projects using advanced treatment range from $600 to $800 per acre-foot. Desalination of ocean water is estimated at over $1,000 per acre-foot. An acre-foot is 325,850 gallons or approximately enough water for 2 families for one year.

Cheryl McGovern responds:

It should be considerably more efficient to process filtered wastewater effluent by reverse osmosis than to process sea water due to the much lower level of total dissolved solids in the filtered wastewater effluent. This is going to vary depending upon a number of variables, such as the quality of water being desalinated and the available options for disposal of the waste brine stream generated by desalination.

Dr. Bahman Sheik, an expert on water recycling, has stated that treating wastewater is about six times more efficient than reverse osmosis of ocean water because it requires less energy. He has pointed out that not all ocean water is clean. A lot of wastewater is discharged into the ocean from coastal cities, ocean-going vessels such as large cruise ships, cargo ships and smaller pleasure boats, as well as industries, etc.

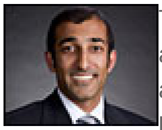
Elvis Delahoz of New York, N.Y. asks
Has there been a significant breakthrough in water filtering technology recently? Dean Kamen (inventor of the Segway) came up with a water purification system that generates power. Are any inventions like this in use on large scale?

Cheryl McGovern responds:

The primary role of the U.S. Environmental Protection Agency is to protect human health and the environment through the regulation of water quality at the tap and in the country's surface waters. The agency typically isn't involved in the development of new water filtering technology. However, we believe many people are working on new technologies because there is a great need for more cost-effective treatment processes. Significant progress continues to be made in more energy efficient and effective wastewater treatment equipment. More information about this is available here.

NOTE: As was noted in a 2003 Time magazine article, Kamen's device uses waste heat from an electric generator to distill water -- boil it and condense it. The article notes Kamen has come up with a way to do it using as little energy as possible. While 1,000 watts of heat won't boil much water, Kamen developed a closed system, powered by whatever fuel is at hand, that traps and recycles the energy released when the boiled water vapor recondenses, resulting in a low-power, low-maintenance device that he claims will cost around $1,000 to manufacture and makes 10 gallons of drinkable water per hour.

Shivaji Deshmukh responds:



Technological advances in water treatment have definitely made wastewater purification more affordable and energy efficient. While reverse osmosis has been around since the 1960s, advances in membranes have resulted in treatment that produces higher quality water using less energy in a smaller footprint.

The GWR System is considered a leading example in the field of water purification. The state-of-the-art purification process used with the system can be replicated in other arid coastal regions of the world to address a looming global water crisis. In fact, the GWR System has already been replicated on a smaller scale in Singapore, and other parts of the world such as Australia are looking at GWR System technologies to satisfy their water needs.

Dan Graham of Pittsboro, N.C. asks

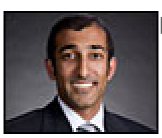
Why hasn't the composting toilet been considered? Eliminate fecal material and the rest of household waste water can be cleaned on site for reuse. The flush toilet works if there is an abundance of water but that is no longer the case in many places.

Cheryl McGovern responds:

Composting toilets are an option for many people who are willing to operate and maintain them. They are typically not chosen as the best option for use in a community-wide application because they are impractical for many users. In community service areas, residents include elderly, disabled and small children who would be challenged by their required maintenance.

There may be state and/or local laws that restrict or condition the use of composting toilets. As you suggest, composting toilets are an option that are being used under a wide variety of circumstances. We can't recommend specific products, manufacturers, distributors or stores, but you can even buy composting toilets -- such as the BioLet 60 XL Electric Composting Toilet, Automatic Mixer or the BioLet 30 NE Non-electric composting toilet -- at places such as Home Depot.

Shivaji Deshmukh responds:

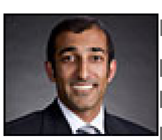


I will defer to Cheryl's answer on this one.

Michael Snider of Napa, Calif. asks

Napa is discussing distributing treated water back to the town, and the topic of excreted pharmaceuticals has become of concern. My question is, if one wishes to remove most (or all) drug-like compounds, what additional steps would be required?

Shivaji Deshmukh responds:



More sensitive analytical measurements have allowed water agencies recently to find the presence of pharmaceuticals in water at very low trace levels. Orange County Water District began testing for pharmaceuticals in anticipation of the Groundwater Replenishment System beginning operation in 2008.

Water purified by the Groundwater Replenishment System contains no detectable pharmaceuticals. Reverse osmosis has been proven to remove pharmaceuticals.

It is important to note that detection methods are still being developed and as they are, water will be tested to ensure that safe levels remain. Currently, researchers do not believe that there is any human health risk from the extremely low trace levels of pharmaceuticals in water, but research into this question is continuing.

Cheryl McGovern responds:

The Orange County Groundwater Replenishment System project uses advanced wastewater purification processes, including microfiltration, reverse osmosis, ultraviolet light and hydrogen peroxide to treat wastewater. The resulting product meets state and federal drinking water standards before returning to the groundwater basin via infiltration through soil that has been demonstrated to effectively remove such compounds.

EPA has been funding research on the effects and treatment of chemicals related to excreted pharmaceuticals. One study released last summer by the American Water Works Association Research Foundation confirms that these chemicals can be removed through currently available treatment methods. The report is titled "Removal of EDCs and Pharmaceuticals in Drinking and Reuse Treatment Processes," by Snyder, Wert, and Lei (Southern Nevada Water Authority) and Westerhoff and Yooz (Arizona State University).

The conclusion of their study is that endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products as pollutants (PPCPs) occur in U.S. drinking water only at minute concentrations so it is highly unlikely that most of these chemicals will pose any credible threat to human health via drinking water exposure. They further recommend regulatory agencies consider human health protection, and not simply trace occurrences, in establishing subsequent monitoring requirements and regulatory limits. They suggest future research should focus on determining the toxicological significance of trace occurrence of various contaminants to establish sensible analytical detection limits and treatment goals.